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A possible novel Terahertz Detection based on Tunable nanometric Nb islands Flux Array Device

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We recently assembled a nanometric pattern of niobium islands as a controllable regular fluxon-array used to investigate the phase transitions of stable and metastable states (vortex insulator-vortex metal state) in competing regular vortex configurations [1].
This system shows the evidence of Shapiro steps at gigahertz frequencies [2]. Such device has suggested the possibility to design a conceptually new radiation detector with unique properties [3]. These pattern structures of size 80 µm x 80 µm made by 300 X 300 Nb islands were realized on a silicon/silicon oxide substrate where a metallic gold template has been grown with four contacts. On this 'template'the array of niobium superconducting islands was realized with a period of ~270 nm. The island diameter is 220 nm, the separation 47 nm and the island thickness 45 nm.
An applied magnetic field in the range 0-100 mT can induce the localization of different magnetic-vortex arrays between the superconducting islands, because of the weak superconductivity proximity effect. Different period 'Josephson vortex flux lattice configuration'(JV) can be selected using this applied magnetic field. The thickness and the separation of the superconducting Nb islands were comparable to the London penetration depth ⊠L≈90nm at T=0 K, so that a strong inductive coupling was achieved between junctions.
JV can scatter electromagnetic waves and when their fast motion with velocity v exceeds a certain threshold vmin in the Flux flow regime has been observed an e.m. emission in the THz-range [4], i.e. the velocity exceeds the lowest characteristic velocity of the Josephson plasma wave. In this process a Cerenkov-type radiation is emitted and can interacts with the periodic flux array itself. An incident THz wave can resonantly excite the surface Josephson plasma wave at certain angles between the incident wave and the sample surface. This results in a strong increase of the absorption of THz wave in the sample and of the resonant peak of the sample resistance [5,6]. A simple I-V technique may control the dynamic state of the superconducting system. The goal is to test this new nano-sized superconducting device as a Terahertz radiation detector under a magnetic field and vs. temperature.

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